Letter from Mauro, Cameron, Lewis & Massie to Alexander Graham Bell, June 12, 1911

S. T. CAMERON. LAW OFFICES TELEPHONE: Washington, Main 3461. REEVE LEWIS. OF New York, 5251 Beekman. C. A. L. MASSIE. **MAURO, CAMERON, LEWIS & MASSIE,** CABLE ADDRESS: Mauro—Washington. Phimauro—New York. F. A. HOLTON. Patents and Patent Causes, CODES USED: Liebers. W. B. KERKAM. Western Union. RALPH L. SCOTT. **622 F. STREET, WASHINGTON, D. C.** Marconi. (TRIBUNE BLDG., 154 NASSAU ST., NEW YORK.) **WASHINGTON.** June 12th, 1911. Dr. Alexander Graham Bell, Beinn Bhreagh, Near Baddeck, Victoria County, Cape Breton, Nova Scotia. Dear Dr. Bell:—

Bell et al., Serial N o 488, 779, filed April 8th, 1909, Flying Machines .

All of the claims of this application have been rejected by the Patent Office, for the most part on a large batch of French references that were received by the U. S. Patent Office subsequent to the date of their first official action, in which they indicated that a number of claims in the case were allowable. The effective dates of most of these patents as references are such that we think said patents may be overcome by the filing of appropriate affidavits. All of the references are very pertinent, but we need not at this time to impose upon you a discussion of the same. We enclose herewith, however, printed copies of French patents Nos. 356, 842, Laroze, and 380, 073, Ferber, with which we anticipate having the most trouble. In connection with the latter, if the conception of this joint invention was prior to November 28th, 1907 (the effective date of this French patent as a reference), the same will be overcome, and we need pay no further attention to it. That will, however, still leave for careful consideration the French patent to Laroze. This patent, as you will appreciate from a consideration of the specification and drawings, is

very pertinent indeed, and we should be happy to have you carefully analyze the same, and let us have the benefit of any suggestions that you may have to make.

We enclose herewith an affidavit that we desire you to execute. Please carefully determine the several dates in question, and insert them in this affidavit. We also enclose herewith affidavits similar to your own for execution by Messrs. Baldwin, Curtiss and McCurdy. Please see that the proper dates are also inserted in these affidavits, and have them returned to us as soon as possible. Inasmuch as our response to the last official action is due on or before July 13th, 1911, please see that the matter of completing and executing these affidavits is promptly attended to, so that we may have the same in our hands in season to reply to the official letter before the date indicated. We would be obliged if you would first attend to the matter of the execution of these affidavits, and thereafter let us have your views regarding this Laroze French patent.

With best regards, we remain,

Yours very truly, Mauro Cameron Lewis & Massie K-F. Encs. Per

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Affiliation as original, prepared. After connection the subject matter was split up into district applications, one in the name, F. W. Baldwin, and the other in the in the joint names of Bell, Baldwin, McCurdy, Curtiss, and Selfridge.

This invention relates to flying machines, and more particularly to that class of flying machines ordinarily known as aeroplanes, and has for its object to produce a machine of this character which shall combine maximum strength and minimum weight; shall be readily steered, caused to rise or descend at the will of the operator, and shall possess means for maintaining its lateral balance or equilibrium, or of restoring said balance or equilibrium if the same becomes disturbed; shall be capable of rising at the commencement of a flight without the use of any launching apparatus, platform or similar

device; shall be capable of ready assemblage or disassemblage, and readily packed in a compact space for transportation.

It has heretofore been proposed to construct machines of this character in which the aeroplanes or supporting surfaces are made flexible and the marginal portions thereof are warped or flexed so that the different ends of the aeroplanes on the opposite sides of the longitudinal medial line of the machine present different angles of incidence; that is, the marginal portion of the aeroplanes on one side presents a greater angle of incidence than does the marginal portion on the opposite side of the machine for the purpose of restoring the disturbed lateral balance or equilibrium of the machine as a whole. This is open to the objection that the side of the machine presenting the lesser angle of incidence will advance in the forward line of movement more rapidly than the side of the machine presenting the greater angle of incidence, thereby imparting a turning movement to the machine toward that side presenting the greater angle of 3 incidence, and to overcome this and cause the machine to move in a straight line forward, it has been found necessary to employ a vertical steering rudder in combination with the flexible aeroplanes.

In contradistinction to this construction, the machine of the present invention is provided with rigid non-flexible aeroplanes or supporting surfaces, and means distinct from the supporting surfaces themselves are provided, in combination with said rigid aeroplanes or supporting surfaces, for causing the lower side of the machine to rise and the higher side of the machine to descend for the purpose of restoring the lateral balance thereof when the same has been disturbed. Any suitable means capable of accomplishing this result may be employed, and as here shown said means consist of lateral balancing rudders located on opposite sides of the longitudinal medial line of the machine, and preferably near the lateral extremities of the aeroplanes. These lateral balancing rudders form no part of the aeroplanes or supporting surfaces and may be located between the rigid aeroplanes or just beyond the marginal edges of the planes, or otherwise, as desired, suitable operating wires or other connections extending therefrom to an operating lever controlled by the aviator, and preferably arranged so as to be automatically operated

by the movements of the aviator's body whenever the lateral balance of the machine is disturbed.

One of the distinguishing features of the present invention resides in a construction whereby the superposed rigid aeroplanes constituting the supporting surfaces are of a concavo-convex form with their concave sides adjacent to each other so that their central portions are farther apart than their marginal portions, instead of the planes being 4 parallel to each other as in the constructions heretofore employed. This presents several advantages. It lends itself to rigidity of construction of the machine as a whole; it has advantages when the machine is struck by cross— currents of air during flight; and since the marginal portions of the lower aeroplane or supporting surface are up-turned, so to speak, it enables these portions to clear obstacles which would otherwise be struck by such portions when the machine is on the ground.

This rigid structure is mounted on a suitable chassis or framework, preferably supported on wheels, one of which serves as a steering wheel to control the forward line of movement of the machine when it is on the ground. The machine is also provided with a suitable vertical steering rudder for giving direction to the line of flight when it is in the air, and preferably the steering wheel above mentioned and said vertical steering rudder are connected to a single operating mechanism whereby the steering wheel and vertical rudder are simultaneously operated, to the end that the rudder may be placed in a proper position to continue the machine in the same direction when in the air that it has at the instant it leaves the ground.

In order to facilitate repairs in case of breakage of a part of the framework of the machine; and in order to provide for the ready assemblage and disassemblage of the machine for transportation, the framework of the aeroplanes, and the various other parts are made in sections, and some of the parts (particularly the framework of the aeroplanes and the struts) preferably are united into a rigid structure by suitable metallic sockets at the joints, and the whole bound together into a rigid unyielding structure by a system of guy-wires.

There are various other specific features of improvement which will be described more in detail hereinafter and then pointed out in the claims.

The inventive idea involved in the machine of the present invention is capable of receiving a variety of mechanical expressions one of which, for the purpose of illustrating the invention, is shown in the accompanying drawings; but it is to be expressly understood that said drawings and the particular construction shown therein and described in the specification are employed simply for the purpose of facilitating the description of the invention as a whole and not for the purpose of defining the limits of the invention, reference being had to the claims for this purpose.

Referring to the drawings, in which like reference numerals indicate like parts, —

Fig. 1 is a top plan view of the machine;

Fig. 2 is a plan view of one of the aeroplanes or supporting surfaces;

Fig. 3 is a front elevation with the horizontal steering rudder and the mechanism for controlling the same omitted and showing one way of mounting the lateral balancing rudders;

Fig. 4 is a like view showing a different way of mounting said lateral balancing rudders;

Fig. 5 is a horizontal section through two of the vertical struts on the line 5-5 of Fig. 4, and showing the bow-string truss-wire;

Fig. 6 is a horizontal section through the forward rib of one of the aeroplanes showing the means of attaching the central vertical struts thereto;

Fig. 7 is a vertical section on the line 7-7 of Fig. 4 looking in the direction of the arrows;

Fig. 8 is a perspective of the forward or horizontal rudder and its supporting frame and operating mechanism;

Fig. 9 is a broken detailed perspective view of one end of the aeroplanes or supporting surfaces showing the manner of mounting the lateral balancing rudders between the aeroplanes;

Fig. 10 is a like view showing the manner of mounting said lateral balancing rudders beyond the lateral marginal lines of said aeroplanes or supporting surfaces;

Fig. 11 is a vertical section through the superposed aeroplanes extending from front to rear and illustrating the curvature of said planes at or near the central portion of the machine;

Figs. 12 and 13 are details illustrating the gradual decrease in curvature of the planes toward the lateral marginal portions thereof;

Fig. 14 is a sectional detail showing the laminated construction of the ribs for the planes;

Figs. 15 and 16 are broken details illustrating the manner of constructing the framework of the aeroplanes or marginal surfaces;

Figs. 17, 18, 19, 20 and 21 are detailed views illustrating joints in the construction of the machine as a whole.

Referring to the drawings in which like numerals indicate corresponding parts, 1 is the upper and 2 the lower one of a pair of superposed aeroplanes of concavo-convex form (suitably spaced by vertical struts) with their concave sides turned towards each other. The general form of construction of the two aeroplanes or supporting surfaces 1 and 2 is the same, and, therefore, a specific description of one will suffice for both. A plan view of these aeroplanes is 7 shown in Fig. 2. Generally stated, each of the aeroplanes is provided

with a frame 4 preferably rectangular in form over which is stretched a suitable fabric constituting the supporting surface proper, which fabric is preferably impervious to air, the front line of the fabric corresponding with the front line 5 of the framework 4, the lateral marginal lines of the fabric, and, therefore, of the supporting surface corresponding with the lateral marginal lines 6 and 7 of the framework. The rear line, however, of the fabric extends at the central portion a suitable distance beyond the rear member of the frame 4 and at the central portion of the machine this rearward extension is greater than at any other portion, gradually tapering off from the central portion towards the lateral marginal lines 6 and 7 where the depth from front to rear of the fabric constituting the supporting surface is approximately equal to that of the frame 4.

The framework 4 is preferably of wood, and, in cross-section, may be of any desired shape, preferably, however, that shown at 8 in Figs. 16 and 21. Preferably also the front and rear members of the framework are not made of a single integral piece but are made up of sections whose ends abut each other, said ends fitting in a suitable socket 9 (see Figs. 15 and 16), the sections at the central portion of the framework being the larger and gradually becoming smaller out towards the lateral margins of the frame. The framework is provided with transverse members 10 extending from the front to the rear member of the frame at suitable intervals, and which members 10 are preferably formed of some light metallic tubing and are joined to the sockets 9 in any suitable manner.

For the sake of giving the desired surface shape to the fabric constituting the supporting surface and also for the 8 purpose of stiffening the same, ribs 11 are provided which fit in pockets 12 in the fabric, which pockets extend from the forward line of the supporting surface to the rear thereof and are preferably uniformly spaced. These ribs may be constructed in any suitable manner and of any suitable material, but preferably they are made of a laminated structure composed of several layers of wood glued together, as shown in cross section in Fig. 14. This manner of forming the ribs gives a strong structure and also enables the ribs to maintain the curved form hereinafter referred to. These ribs preferably are not fixedly secured to the framework but have their forward ends abutting

the forward member of the frame, as clearly shown in Figs. 11, 12 and 13, and their forward portions extending under but adjacent to the rear member of the framework. Moreover, these ribs are not straight but are of the curved formation shown in Figs. 11, 12 and 13. At the central portion of the machine the curve at the forward portion of the rib is such as shown in Fig. 11, and from the central portion outward toward the lateral margins of the machine the curve becomes less and less in the ribs, as shown in Figs. 12 and 13, until the rib next to the lateral marginal portion of the machine has a very slight curvature, such, for example, as that shown in Fig. 13. A wire or chord extends from one rear marginal corner of the framework along the rear ends of the several ribs to the other or rear marginal corner, said chord or wire suitably engaging the rear end of each rib, preferably by passing through an opening 13 formed in the rear end of each rib (see Figs. 11, 12 and 13). The sectional frame having been assembled with the ends of the several sections abutting each other within the sockets 9 and the transverse members 10 having been put in place and preferably riveted to said sockets, 9 the entire framework is stiffened and held together by a series of diagonal cross wires 14, shown in dotted lines in Fig. 2, said cross wires being secured to the sockets in any suitable manner, as, for example, by the adjustable clips 15, Figs. 17 and 18, provision being made for tightening the wires 14 by any suitable means, as the nuts 16 on the threaded rods 17.

The two aeroplanes being thus constructed are superposed one above the other and are separated by suitable vertical struts 18. These struts, however, are not fixedly secured to either the members 4 or the sockets 9, but preferably have their upper and lower ends entering sockets 19, the one extending upward from the socket 9 on the lower aeroplane and the other extending downward from the socket 9 on the upper aeroplane, as will be readily understood from an inspection of Figs. 11, 17 and 18. The socket member 19 may be secured to the socket 9 in any suitable manner, as by the bolt and nut construction 20 shown in Fig. 17.

Near the central portion of the machine the struts 18 are placed somewhat close together, as shown in Figs. 3 and 4, and from this central portion outward toward the marginal lines

of the aeroplanes they are placed preferably at wider intervals. The length of the struts at the middle portion of the machine is approximately that of the depth of the aeroplane at that point from front to rear, and the lengths of the other struts to one side of the central struts out to the marginal lines of the aeroplanes gradually decreases, such length, however, of any given strut being approximately equal to the depth of the aeroplane from front to rear at the point where the strut is placed. There is a forward series of these struts resting on the forward line of the framework 4 and a rear series of these struts resting on the 10 rear portion of said framework.

The struts being thus assembled in position with their upper and lower ends entering the sockets 19, the entire structure is bound together into a rigid whole by means of a series of truss-wires. Thus, referring to Figs. 3 and 4, there are truss-wires 21 extending from the top of each strut to the bottom of each strut on the opposite sides thereof and from the bottom of each strut to the top of each strut on the opposite sides thereof. In addition to this, there are preferably truss-wires extending from the top of each forward strut to the bottom of each strut immediately in the rear thereof and from the bottom of each forward strut to the top of each strut immediately in the rear thereof, as is shown by the truss-wires 22, 22, Fig. 11. All of said wires are provided with suitable means for tightening the same, as, for example, the screw-threaded rod 23 and nut 24, as shown in Fig. 17, which rod and nut are connected to a suitable clip 25. Any other suitable means for tightening the truss-wires and any other suitable form of socket for receiving the ends of the various members may be employed without departing from the spirit of the present invention, but the form shown and described has been found to be efficient and is the one preferred.

Referring to Figs. 3 and 4, it will be seen that the middle struts 18 are considerably longer than the struts on each side thereof, and particularly, longer than the marginal struts 18, and that, therefore, if the central struts are of the same transverse sectional area as the shorter marginal struts, they would, by reason of their greater length, bend or yield more readily under the same bending strain, and to avoid this it would ordinarily become necessary to increase the cross sectional 11 area of the longer struts over that of the

shorter struts. But as this increase in cross sectional area would mean not only increase in weight to the machine but an increased resistance to the forward movement of the machine through the air, provision is made by the present invention for maintaining the cross sectional area of all of the struts substantially the same, and this at the minimum. This is accomplished by means of transverse bow-string truss-wires 26 extending as chords, so to speak, from each corner of each aeroplane entirely across the machine in a straight line, said bow-string truss-wires being secured to and preferably passing through each of the struts. Preferably each chord or truss-wire is made in sections so as to adjust the lengths of the respective portions thereof between the respective struts, which adjustment is provided for by means of the nut and screw-threaded connections 27, illustrated in detail in Fig. 5, in which the screw-threaded rods 28, forming a part of the truss-wires 26, pass through the struts 18 and are fixedly secured to the said struts in the manner clearly illustrated in Fig. 5. When the bow-string truss-wire 26 is thus applied, the portions of the longer struts that would yield to the bending strain are those portions lying between the two truss-wires in Figs. 3 and 4, and, as these wires are parallel, it follows that the portions of the struts included between them are of equal length, and, therefore, may be of equal cross sectional area.

With the two aeroplanes thus assembled the front elevation of the machine will be that shown in Figs. 3 and 4, thickest, and, therefore, strongest at the centre where the greatest strain occurs and gradually tapering spar-like from this point of greater strain towards the marginal portions where the least strain occurs.

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The aeroplane or supporting surfaces thus superposed one above the other and united together, are mounted on a suitable chassis or frame 29, Fig. 7, which frame is supported on three wheels 30, 31 and 32, the forward wheel 30 being mounted in any suitable steering head 33, such as that of the ordinary bicycle or motorcycle construction, for example, which steering head is controlled by a steering lever 34, Fig. 7.

Extending rearward from the central portion of the machine is a frame 35 preferably made of any light material, as bamboo, which at its rear supports a vertical rudder 36, and, if desired, a steadying tail-piece 37, the latter being in the form of a rectangular cell whose upper and lower surfaces are covered with a suitable fabric, the cell between said surfaces, however, being open from front to rear. The vertical rudder may be supported in any suitable position, but preferably, and as herein shown, is supported to the rear of the steadying tail-piece 37 and is mounted on vertical pivots and provided with means for turning it about said pivots. Said means, as here shown, are in the form of wires or cables 38, 38, extending from opposite sides of the vertical rudder to a steering wheel 39 secured to and mounted to turn on or with a shaft 40. This shaft is supported on a framework 41 extending forward from the front portion of the machine and supports the horizontal rudder 42, pivotally mounted at the forward end of the frame 41, so as to turn about a horizontal axis and provided with an operating lever 43, pivotally connected at 44, to the shaft 40 of the steering wheel 39, said shaft 40 being mounted not only to turn in its bearings 45, 45, but also to slide longitudinally therein. By the turning movement of said wheel 39 the steering wires or cables 38 are controlled to operate 13 the vertical steering rudder 36, and by sliding the rod 40 in its bearings 45, the lever 43 may be operated to adjust the horizontal steering rudder 42 to any angle desired. If placed at a positive angle of incidence it will have a tendency to lift the forward portion of the machine, and, therefore, to cause it to rise. If placed at a negative angle of incidence it will cause the machine to descend, and, if placed at a neutral angle, will act to hold the machine on any given horizontal course.

The operator sits grasping the wheel 39 and by pushing the wheel from him and thus sliding the rod or shaft 40 in its bearings he can operate the horizontal rudder 41 in one direction through the lever 43, and by pulling the wheel towards him and with it the shaft 40, he can operate the horizontal rudder in the opposite direction. It will be seem, therefore, that the aviator controls the vertical rudder which gives the line of direction and the horizontal rudder which determines the rise or descent of the machine through the

single wheel 39. In addition to this, the wires or cables 38 leading to the vertical rudder 36 are also connected on either side to the wires 46, 46 (Fig. 8) attached to the steering lever 34 which controls the front steering wheel 30 on the chassis, so that at the same time that the steering wheel 39 is operated for adjusting the vertical steering rudder, it also operates, and to the same degree, the front steering wheel 30 on the chassis. It therefore follows that if the machine is controlled by the front steering wheel 30 so as to move in any given direction while on the ground, the vertical steering rudder 36 will be in the proper position to have the machine continue in the same line of flight when it rises from the ground; and vice versa if the machine is in the air and the vertical rudder 36 is adjusted to direct 14 it in any given line of flight, the front steering wheel 30 will be adjusted precisely the same, with the result that when the machine alights it will continue to move forward in the same direction in which it was moving in the air at the instant before it touched the ground.

One of the most important features of the present invention is that provided for restoring the lateral equilibrium of the machine when, for any reason, the same has become disturbed. In the present invention this is accomplished by providing a plurality of lateral balancing rudders placed on opposite sides of the longitudinal medial line of the machine. In some forms of the invention there are two such rudders, one on each side of the longitudinal medial line, which rudders are preferably of equal area and are mounted to turn on horizontal axes extending by preference parallel with the front line of the machine. These lateral balancing rudders may be placed in any suitable position with respect to the aeroplanes or supporting surfaces 1 and 2, and have as their sole function the maintenance or restoration of the lateral equilibrium, since they are entirely independent of and do not in any sense constitute a part of the supporting surface of the machine.

Said rudders may be placed above the aeroplanes or below them, or otherwise. As shown in Figs. 3 and 9, they are placed between the aeroplanes. In said Figures, 47 indicates the lateral balancing rudders, which consist of a suitable framework 48 covered by a proper fabric and pivoted at its forward margin at 49, 49, to a part of the framework of

the machine, here shown in the form of a horizontal bar 50 extending between two of the forward series of struts 18, 18. It will be understood that there are at least two of these 15 balancing rudders 47, one on each side of the longitudinal medial line of the machine, as shown in Fig. 3, and that normally when the machine is in a state of lateral equilibrium, these balancing rudders are maintained horizontal to, that is, within the plane of the line of flight of the machine, and, since the pressure of the air above and below said lateral rudders is the same (owing to the fact that normally said rudders incline to neither a positive nor a negative angle of incidence) they constitute no part of the supporting surface of the machine as a whole. When, however, the lateral equilibrium of the machine has become disturbed that rudder on the lower side of the machine is inclined to a positive angle and that rudder on the higher side of the machine is inclined to a negative angle of incidence, so that the one tends to lift the lower side of the machine and the other to depress the higher side of the machine, thereby acting to again bring the machine into a state of lateral equilibrium or on an even keel. Even when so operated these rudders do not constitite a part of the supporting surface of the machine, since the rudders are of the same area and one being inclined at a negative and the other to an equal but positive angle of incidence, the lifting action of one is neutralized by the depressing action of the other.

In the construction just described but two lateral balancing rudders are employed. If preferred, however, more than two may be employed, as, for example, four such rudders may be used and may be mounted in any suitable manner, preferably beyond or outside of the lateral marginal lines of the aeroplanes or supporting surfaces. For the purpose of thus mounting these lateral balancing rudders outside of or beyond the lateral marginal lines of the aeroplanes or supporting 16 surfaces, the forward members of the frame of each aeroplane are extended outward beyond said lateral marginal lines, as shown at 51, 51 (Figs. 4 and 10), and to these extensions the lateral balancing rudders 52, 52 (here shown as triangular in form) are pivoted as at 53, 53. Preferably and as here shown, there are two pairs of these lateral balancing rudders, one pair on each side of the machine, each of the

rudders being mounted to turn on horizontal axes outside of the lateral marginal lines of the aeroplanes or supporting surfaces.

Like the rudders 47 shown in Figs. 3 and 9, these rudders normally lie in a horizontal plane, that is, they are inclined neither at a positive nor a negative angle of incidence, and, hence, do not constitute any part of the supporting surfaces of the machine. If, however, the lateral equilibrium of the machine is disturbed, that pair of rudders on the lower side of the machine is inclined at a positive angle of incidence and that pair on the higher side of the machine is inclined at a negative angle of incidence precisely as described in connection with the lateral balancing rudders 47, 47, shown in Figs. 3 and 9, and, since the area of the balancing rudders on one side of the machine is the same as the area on the opposite side of the machine, and since each pair of rudders is inclined (for the purpose of restoring equilibrium) at the same angle of incidence, the one, however, being positive and the other negative, the lifting effect of those rudders inclined at the positive angle of incidence is neutralized by the depressing effect of the other pair of rudders inclined at a negative angle of incidence, so that the lifting effect of the two pairs of rudders combined, is zero. It will thus be seen that whatever may be the form or the position of the 17 lateral balancing rudders employed, their sole function is that of restoring the lateral equilibrium of the machine, and that they do not constitute any part of the supporting surface of the machine as a whole.

For the purpose of controlling these lateral balancing rudders, whether the same are mounted between the aeroplanes or supporting surfaces or beyond the lateral margins of said aeroplanes or supporting surfaces, or otherwise, suitable operating wires or cables 54, 54, are secured to said rudders and are led through suitable pulleys 55, 55, (Figs. 9 and 10) to a lever 56 (Fig. 1) pivoted at its rear end 58 to any suitable part of the machine, as, for example, one of the rear members of the framework. This lever is provided with any suitable means whereby the aviator may shift the same on its pivot or fulcrum 58. Preferably, and as here shown, the lever is provided with forwardly extending arms 59, which, together constitute approximately a semi-circle and are so positioned that when

the aviator is sitting on the seat 60 they embrace his body below his arms. When the lateral equilibrium of the machine is disturbed and one side, for example the right hand side of Fig. 1, is depressed, and the other side, as the left hand side of Fig. 1 is raised, the instinctive movement of the aviator will cause him to lean toward the higher side, that is, toward the left hand side of Fig. 1, and he will, therefore, shift the lever 56 from right to left in Fig. 1. This shifting of the lever acts to effect a pull on the rudder controlling wire or cable 54 leading to the balancing rudder on the lower side of the machine, thereby drawing the rear portion of the rudder downward and incline the rudder at a positive angle of incidence; and at the same time said movement of the lever operates to produce a slack in the wire or cable 54 leading to the 18 balancing rudder on the higher side of the machine so that it may be moved upward at its rear portion, thus inclining it at a negative angle of incidence. Referring to Fig. 9, there is a controlling wire or cable 54# attached to the rear portion of the rudder 47 and extending through suitable guy-pulleys 55# to the upper side of the balancing rudder on the opposite side of the machine, so that when the controlling lever 56 is operated to incline the rudder on the lower side of the machine to a positive angle, a pull is effected on the wire or cable 54# which operates to incline the balancing rudder on the opposite or upper side of the machine to a corresponding negative angle.

Referring to Fig. 10, the wire or cable 54# extending from the balancing rudders to the balancing rudders on the opposite side of the machine, as well as the cables 54 extending directly to the lever 56, are preferably attached respectively to the bottom and top portions of a strut 61 extending between the two rudders 52, 52, as shown in Fig. 10, so that a pull on the cable or wire 54# and a corresponding slack on the cable 54 operates to set the rudders 52, 52, at a negative angle of incidence, whereas a pull on the wire or cable 54, and a corresponding slack on the wire or cable 54# operates to move the rudders in the reverse direction.

Any suitable means may be employed for propelling the machine, and, as here shown, such means consist of a motor 62, mounted in the middle portion of the machine and

suitably geared to a proper shaft for driving a single propeller 63, at the rear of the machine, but, as the specific construction of motor and mounting of the propeller form no part of the present invention, it will not be unnecessary to describe the same more in detail.

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While the several struts 18 of the machine are preferably held in position by their upper and lower ends resting in sockets 19, as illustrated in Figs. 17, 18, 19, 20 and 21, the two struts lying immediately on opposite sides of the longitudinal medial line of the machine are preferably secured fixedly to a portion 4# of the framework of the machine, and, as here shown, (Fig. 6), this is accomplished by bolting metal bars 65, 65, to said struts with the screw-threaded ends of the bars projecting beyond the struts and through the portion 4# of the framework where they are engaged by nuts 66, so that said struts and the framework are fixedly united. In this construction the guy-wires 14 are provided with eyes through which extend the projecting portions of the metal bars 65, 65, so that the guy-wires, the struts and the framework 4# are all secured together by the two bars of metal 65 and the nuts 66, as will be readily understood from an inspection of the drawing.

As before described, the members 10 extending from the front to the rear members of the framework of each aeroplane do not extend to the rear beyond the framework, and for the purpose of affording a suitable support for the wire which leads through the rear ends of the ribs 11 in the middle portion of the machine, bracket arms 67 (Fig. 16), extend rearward from the rear frame member 4 and these are provided with openings 68 in their rear ends (Fig. 6) for receiving the wire which supports the rear edge of the fabric constituting the supporting surface. These bracket-arms 67 are supported in sockets 69 riveted or otherwise secured to the sockets 9. These rearwardly extending bracket arms are only employed at a point on each side of the longitudinal medial portion of the machine and their employment is rendered desirable by reason 20 of the fact that the ribs 11 would

otherwise be spaced too far apart, and, therefore, would not afford suitable support for the fabric at this point.

To launch the machine at the beginning of a flight, the same is placed upon the ground, as shown in Fig. 7. The aviator takes his position on the seat 60 (Fig. 1) with the fork 59 embracing his body and his hands grasping the wheel 39 and the horizontal forward rudder being in substantially a horizontal plane. The engine being started the machine is driven along the ground and is controlled by the aviator through the wheel 39, and the forward steering wheel 30 on the chassis. When the machine has reached the desired speed on the ground, the aviator pulls the steering wheel 39 toward him and thus inclines the horizontal steering rudder to a positive angle of incidence, as, for example, that shown in Fig. 7, thereby elevating the forward portion of the machine slightly and inclining the aeroplanes or supporting surfaces 1 and 2 at a positive angle of incidence, and thus causing the machine to rise from the ground. At the instant when this occurs, the steering rudder 36 will be set in exactly the same vertical plane as the steering wheel 30, thereby causing the machine to continue in the same forward line of flight as its forward line of movement while on the ground.

During the time that the machine is advancing on the ground, the upward-turned lateral margins of the lower aeroplane or supporting surface enables it to more readily clear any constructions like stones or bushes that may be on either side of the road, and, when the machine has risen in the air, the concavo-convex form of aeroplane renders it less liable to disturbances from cross gusts of wind, since the depressing effect of such cross gusts upon the upper surface 21 of the upper aeroplane will be largely neutralized by the elevating effect of such gust upon the under-surface of the lower aeroplane, so that this concavo-convex structure not only lends itself to great rigidity of construction and facilitates the movement of the machine while on the ground, but also contributes materially to the steadiness of the machine while in the air. Moreover, it is well-known in this art that aeroplanes which are of less depth from front to rear at their marginal portions than at their central portions, possess certain advantages in effecting turning

movements in the air; and furthermore, it has been established that when two aeroplanes are superposed one above the other, the distance between the aeroplanes should be approximately the depth of the aeroplane from front to rear. It will be perceived, therefore, that in the present structure by superposing the aeroplanes one above the other with their concave sides towards each other, there is obtained not only an exceedingly rigid structure, but such a rigid structure combined with the stable qualities of aeroplanes which taper or become narrower towards their lateral margins and that without departing from the principle which requires that the superposed aeroplanes should be spaced the one above the other at a distance equal to the depth of the aeroplanes from front to rear.

It will be understood that the structure thus hereinbefore specifically described may be varied in a great number of its details, and that certain features thereof may be used in the absence of others without departing from the spirit of the invention, and such changes in detail of construction and such uses of some of the features in the absence of others, are intended to be within the scope of the claims hereto appended.

What I claim is:—

1. In a flying machine, the combination of a plurality of superposed suitably spaced aeroplanes each having a concave and a convex surface, and means uniting said aeroplanes with their concave surfaces toward each other.

2. In a flying machine, the combination of a plurality of a concavo-convex aeroplanes united with their concave surfaces towards each other, each of said aeroplanes having its greatest depth from front to rear at its central portion and having a gradually decreasing depth from front to rear between said central portion and its lateral marginal lines.

3. In a flying machine, the combination of a concavo-convex aeroplane, with a chord or truss-wire extending across the concave side of the aeroplane and uniting the opposite lateral edges of the aeroplane.

4. In a flying machine, the combination of a pair of superposed aeroplanes spaced farthest apart at their central portion and gradually approaching each other toward their lateral edge portions, a series of spacing struts arranged in a line extending from one lateral edge of the structure to the other, and a chord or truss-wire extending in a straight line from the lateral strut on one side of the structure to the lateral strut on the other side and secured to each of said series of struts.

5. In a flying machine, the combination of a plurality of concavo-convex aeroplanes united with their concave surfaces towards each other, with a chord or truss-wire extending across the concave side of each aeroplane.

6. In a flying machine, the combination of a plurality of concavo-convex aeroplanes having their concave surfaces toward each other, a front and a rear series of struts, each strut extending from one aeroplane to the other, with a front and a rear chord or truss-wire extending across the concave side of each aeroplane.

7. In a flying machine, the combination of a plurality of concavo-convex aeroplanes having their concave surfaces toward each other, a front and a rear series of struts, each strut extending from one aeroplane to the other, with a front and a rear chord or truss-wire extending across the concave side of each aeroplane and secured to said struts.

8. In a flying machine, the combination of a plurality of superposed concavo-convex aeroplanes having their concave sides towards each other, a series of vertical struts separating said aeroplanes, and diagonal truss members extending from the top of each strut to the bottoms of the adjacent struts on each side thereof.

9. In a flying machine, the combination of a plurality of superposed concavo-convex aeroplanes having their concave sides towards each other, a series of vertical struts separating said aeroplanes, diagonal truss members extending from the top of each strut to the bottoms of the adjacent struts on each side thereof, and a chord or truss-wire

extending across the concave side of each aeroplane in the line of said series of struts and secured to each strut.

10. In a flying machine, the combination of a plurality of concavo-convex aeroplanes having their concave sides towards each other, a front and a rear series of struts, said struts extending from one aeroplane to the other, a diagonal truss member extending from the top of each strut to the bottom of each adjacent strut in the series, and a truss member extending from the top of each strut of one series to the bottom of the opposite strut in the other series.

11. In a flying machine, the combination of a plurality of concavo-convex aeroplanes having their concave sides towards each other, a front and a rear series of struts, said struts extending from one aeroplane to the other, a diagonal truss member extending from the top of each strut to the bottom of each adjacent strut in the series, a truss member extending from the top of each strut of one series to the bottom of the opposite strut in the other series, and a front and a rear chord or truss-wire, each extending across the concave side of each aeroplane in the line of the series of struts and secured to each strut of the series.

12. In a flying machine, the combination of a plurality of concavo-convex aeroplanes having their concave sides towards each other, with a series of struts separating the planes, a chord or truss-wire extending across the concave side of each aeroplane and secured to the struts, and means for adjusting the length of said chord or truss-wire between the struts.

13. In a flying machine, the combination of a pair of suitably spaced aeroplanes, means uniting said aeroplanes, and a pair of lateral balancing rudders one on each side of the medial fore and aft line of the structure.

14. In a flying machine, the combination of a plurality of concavo-convex aeroplanes with their concave sides toward each other, means uniting said aeroplanes, and a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure.

15. In a flying machine, the combination of a plurality of superposed concavo-convex aeroplanes, means uniting said aeroplanes, into a rigid non-flexible structure, and a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure.

16. In a flying machine, the combination of a plurality of aeroplanes, means uniting said aeroplanes, a pair of lateral balancing rudders, one on each side of the fore and aft medial line of the structure and each mounted to turn on a horizontal axis, and means for turning said rudders on their axes.

17. In a flying machine, the combination of a plurality of aeroplanes, means uniting said aeroplanes, a pair of lateral balancing rudders, one on each side of the fore and aft medial line of the structure and each mounted to turn on a horizontal axis, and means for simultaneously turning said rudders in opposite directions on their respective axes.

18. In a flying machine, the combination of a pair of suitably spaced aeroplanes, means uniting said aeroplanes, and a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure, and each of said rudders being mounted outside of the lateral marginal lines of said aeroplanes.

19. In a flying machine, the combination of a pair of suitably spaced aeroplanes, means uniting said aeroplanes, and a lateral balancing rudder mounted outside of each lateral marginal line of each aeroplane.

20. In a flying machine, the combination of a pair of suitably spaced aeroplanes, means uniting said aeroplanes, and a lateral balancing rudder mounted to turn on a horizontal axis outside of each lateral marginal line of each aeroplane.

21. In a flying machine, the combination of a pair of suitably spaced aeroplanes, means uniting said aeroplanes, a lateral balancing rudder mounted outside of each lateral marginal line of each aeroplane, and means inclining the said rudders on one side of the structure at a positive angle of incidence and the rudders on the opposite side of the structure at a negative angle of incidence.

22. In a flying machine, the combination of a plurality of suitably spaced aeroplanes, means uniting said aeroplanes, a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure, and each of said rudders normally having a zero angle of incidence, and means for adjusting said rudders the one to a positive and the other to a negative angle of incidence.

23. In a flying machine, the combination of a plurality of suitably spaced aeroplanes, means uniting said aeroplanes, a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure, and each of said rudders normally having a zero angle of incidence, and means for simultaneously adjusting said rudders the one to a positive and the other to a negative angle of incidence.

24. In a flying machine, the combination of a plurality of suitably spaced aeroplanes, means uniting said aeroplanes, a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure, and each of said rudders normally having a zero angle of incidence, and a controlling lever operatively connected to both of said rudders.

25. In a flying machine, the combination of a plurality of suitably spaced aeroplanes, means uniting said aeroplanes, a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure, and each of said rudders normally having a zero angle of incidence, and a controlling lever operatively connected to both of said rudders and having a part in operative relation with the person of the aviator.

26. In a flying machine, the combination of a plurality of suitably spaced aeroplanes, means uniting said aeroplanes, a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure, and each of said rudders normally having a zero angle of incidence, and a controlling lever operatively connected to both of said rudders and having a part embracing the body of the aviator.

27. In a flying machine, the combination of a plurality of suitably spaced aeroplanes each of which has a part projecting outside of its lateral marginal lines, a balancing rudder fulcrumed to each of said projecting parts and means for operating said rudders.

28. In a flying machine, the combination of a pair of superposed concavo-convex aeroplanes, means uniting said aeroplanes into a rigid non-flexing structure with their concave sides towards each other, a pair of lateral balancing rudders one on each side of the medial fore and aft line of the structure, means connecting said rudders together whereby a movement of one imparts a reverse movement to the other, and operating means connected to both of said rudders.

29. In a flying machine, the combination of a pair of suitably spaced aeroplanes and means uniting the same with a pair of lateral balancing rudders, one on each side of the medial fore and aft line of the structure, means for operating said balancing rudders, an elevating and depressing device, and means for operating said device.

30. In a flying machine, the combination of an aeroplane, a pair of lateral balancing rudders one on each side of the medial fore and aft line of the structure, an elevating and depressing device, a steering rudder, a shaft mounted to move revolubly and longitudinally and operatively connected to said steering rudders and said elevating and depressing device, and means for operating said balancing rudders.

31. In a flying machine, a chassis, wheels for supporting the same, one of which is a steering wheel, an aeroplane mounted on said chassis, a steering rudder, and means for simultaneously operating said steering wheel and said steering rudder.

32. In a flying machine, the combination of a chassis mounted on wheels, one of which is a steering wheel, an aeroplane mounted on said chassis, a steering rudder, an elevating and depressing device, a revoluble and longitudinally movable shaft, and means operatively connecting said shaft to said steering rudder, said steering wheel and said elevating and depressing device.

33. In a flying machine, the combination of an aeroplane and two lateral balancing rudders one on each side of the longitudinal medial line of the aeroplane and pivotally supported on the outside of the lateral marginal lines of the aeroplane, and means automatically operated by the body-movements of the aviator and operatively connected to said balancing rudders.

34. In a flying machine, the combination of a chassis or frame supported on a plurality of wheels one of which is a steering wheel, an aeroplane mounted on said chassis or frame, and mechanism for operating said steering wheel.

35. In a flying machine, the combination of a chassis, or frame supported on a plurality of wheels one of which is a steering wheel, an aeroplane mounted on said chassis or frame, a steering rudder, and means simultaneously operating said steering wheel and steering rudder.

36. In a flying machine, two superposed aeroplanes having sectional frames, the laterally extending sections of which abut each other, struts separating said aeroplanes and abutting the laterally extending portions of the two aeroplanes, and truss members uniting the whole into a rigid structure.

37. In a flying machine, two superposed aeroplanes having sectional frames, the laterally extending sections of which abut each other, struts separating said aeroplanes and abutting the laterally extending portions of the two aeroplanes, and adjustable truss members uniting the whole into a rigid structure.